雪氷写真館⑮　ロシア樺太の雪崩による脱線事故（平成 21 年 12 月 31 日）/ Train derailed by an avalanche, Sakhalin Island, Russia, 31 Dec. 2009

Fig. 1.　Train derailed by an avalanche on 31 Dec. 2009, eastern coast of Sakhalin Island (219 km from Korsakov along the Korsakov-Nogliki railway). Numbers correspond to buried machinery: 1 & 2: locomotive and snow-cleaning car hit by the first avalanche, respectively; 3: breakdown gang's bulldozer hit by the second avalanche.

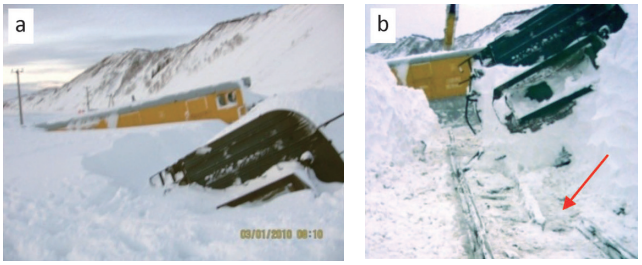


Fig. 2.　(a) Locomotive and 85-ton snow-cleaning car (yellow) buried by avalanche debris.　(b) The removal of snow revealed torsion and rupture of railway sleepers (arrow).

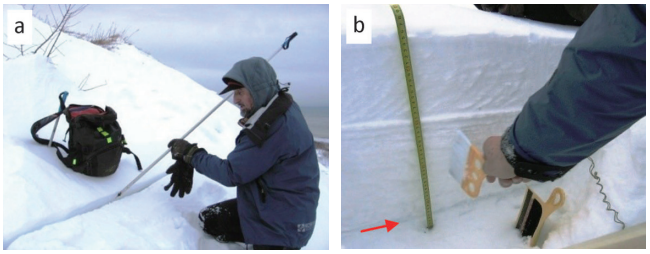


Fig. 3.　(a) Crown face of a fracture at the starting zone of the avalanche (140 m above the railway upon a slope with an inclination of up to 45°) as developed between old and newly loaded snow.　(b) Weak layer beneath a wind slab (arrow).

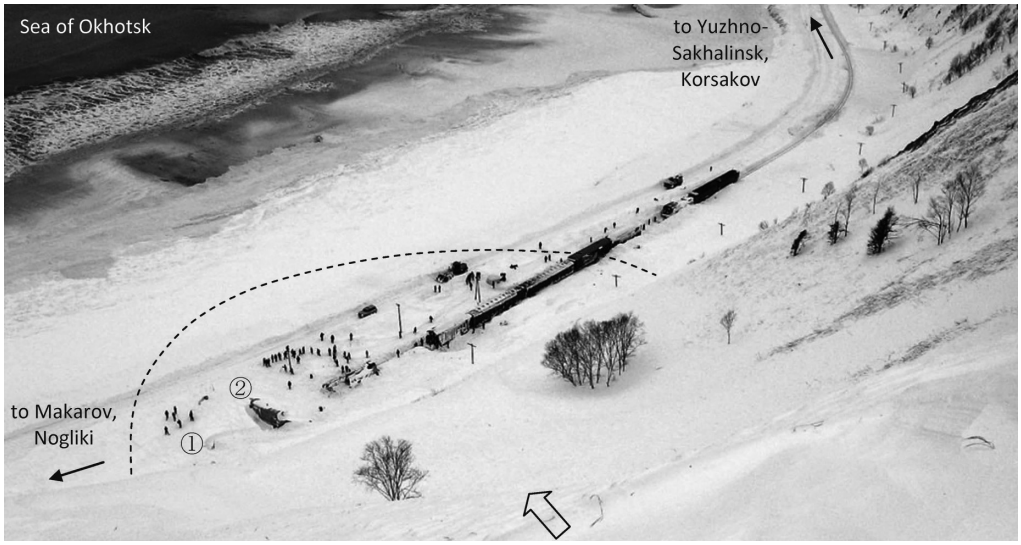


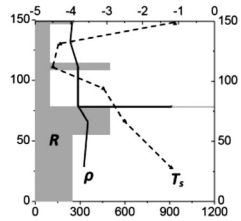
Fig. 4. View of the accident site from the starting zone of the avalanche (dashed line indicates the extent of avalanche debris, which is 40 m wide, 140 m long, and 4.0–7.5 m thick; 1 & 2: locomotive and snow-cleaning car, respectively).

Train derailed by an avalanche, Sakhalin Island, Russia, 31 Dec. 2009

Sakhalin Island（樺太）is one of the most avalanche-prone regions in Russia. Its maritime climate is characterized by heavy snowfall and buried structural weaknesses in the snowpack. During a storm on 31 Dec. 2009, two snow slides collapsed onto the same section of railway along the eastern coast of the island (40 km south of Makarov City). The first avalanche, which occurred at around 9 : 45 am, derailed a diesel locomotive with a snow-cleaning car (Fig. 1, 2, 4). A breakdown gang, consisting of 10 staff and machinery, sought to restore the railway service but was hit by a second avalanche at around 10 pm, resulting in two fatalities. Subsequent observations at the crown of the failed snow slabs revealed a typical weak layer comprising an ice crust buried by a wind slab with a thickness of 47–71 cm (Fig. 3 and Table); the total estimated volume of avalanche debris was $17–28 \times 10^3$ m^3. The railway service was restored on 4 Jan. 2010 based on an expert opinion (V.E. Suchkov) of minimal further risk. It was recommended that an avalanche defense be considered at the site (an avalanche had occurred at the same site in Feb. 2009).

Snow cover profile of the wind-loaded slope above the railway (3 Jan., 2010, observer : V.E. Suchkov).

D (cm)	L (cm)	θ_w, LWS	F	R	ρ (kg m^{-3})	T_s (°C)	Comments
149-146	3	D	⌀	1F	260	-1.1	Wind crust
146-114	32	D	●(／)	4F	250	-4.3	Wind packed
114-108	6	D	⌀	P	320	-4.5	With wind crusts
108-78	30	D	●(／)	4F	300	-3.1	Wind packed, weakly bonded
78-77	1	D	▬	I	917	n/a	Slide plane (Ice crust)
77-55	22	D	●	P	390	-2.5	
55-0	55	D	⍟ ◎◎	1F	340	-1.2	with clusters



Suchkov V.E. (Sakhalin Hidrometeorological Service), Podolskiy E.A. (Nagoya Univ.)